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ABSTRACT

As several initiatives relating to integrating the use of information technologies (IT) were started in Prince Edward Island, the Faculty of Education at the University of Prince Edward Island saw a unique opportunity where the merging of some of the initiatives and collaboration among the participants might be more productive and advance the initiatives with a research basis. Thus, a project to facilitate a partnership among teacher educators, pre-service teachers, classroom teachers, teacher-librarians, and Department of Education consultants was started. This paper focuses on the conceptual issues associated with the development of integrated IT projects. These issues include: learning computer skills contextually; examining the changing role of the teacher; identifying a new continuum for integrating IT into the learning environment; and designing projects from the curriculum to the technology. Examples from the mathematics, language arts, social studies and school library programs where IT projects were implemented are used to support and illustrate these points. Contains 19 references. (AEF)

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Developing innovative information technology projects

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In society, there is a driving force for everyone to be computer literate. What constitutes being computer literate, however, is open to many different interpretations. For some people, computer literacy means keyboarding, or the ability to type. To others, it represents the ability to program in BASIC or some other language. Still others define computer literacy as the ability to use the computer, and its accompanying software, as a tool.

In 1986, Oman and Willson completed a study of published material on K-8 computer curricula. They found that computer literacy was conceptualized in nine main areas as follows: application, careers, history and resources, keyboard skills, problem-solving methods, programming skills, social and ethical issues, structure and function, and vocabulary and general concepts. Since the 1980s there has been an evolution of different characterizations of what it means to be computer literate.

The National Curriculum in the United Kingdom (1995) characterizes information technology skills as being "an ability to use effectively IT tools and information sources to analyse, process and present information, and to model, measure and control external events." They expand upon this characterization by stating that this would involve: "using information sources and IT tools to solve problems; using IT tools and information sources, such as computer systems and software packages, to support learning in a variety of contexts; and understanding the implications of IT for working life and society." (Http://www.ncet.org.uk/info-sheets)

The British Columbia Ministry of Education has outlined foundation, process and presentation learning outcomes for developing information technology literacy from kindergarten to Grade 12. The aim of the foundations is to provide "students with fundamental knowledge, skills and attitudes to use information technology tools in all areas of learning. Process allows students to select, organize and modify information to solve problems. Presentation provides students with an understanding of how to effectively use information technology tools to communicate ideas and information using a variety of media." Each of the outcomes is expanded by grade level and accompanied by integrated resource packages with suggested strategies and content.

The Department of Education on Prince Edward Island developed *A Journey* which is a philosophical stance on how technology will be used in Island schools. Currently, the Department of Education is working on curriculum documents to outline and sequence the essential information technology skills and competencies for students to acquire in Grades One through Twelve.

Regardless of the characterizations, learning outcomes and philosophical stances set forth, in practical terms, there remains a dichotomy between learning to use technology and using technology to learn. This dilemma is at the core of developing innovative information technology projects as the explicit information technology curriculum can be met, normally, using either perspective.

Customarily, information technology projects in the school system have been innovation-driven and focused on learning to use the technology. The new equipment, software or learning outcomes were given to the teacher and she was expected to use the technology with her students. This usually resulted in an emphasis on the development of technology knowledge, skills and processes in isolation from the curriculum areas in which technology could be applied. Thus, the technology becomes one more add-on to the existing curriculum, as happens with most innovations, rather than an integral and integrated component of the learning environment.

The Project

Several initiatives relating to integrating the use of information technologies were started in the province, at the same time but at different levels. The Faculty of Education at the University of Prince Edward Island saw a unique opportunity where the merging of some of the initiatives and collaboration among the participants might be more productive and advance the initiatives with a research basis. Thus, a project to facilitate a partnership among teacher educators, pre-service teachers, classroom teachers, teacher-librarians, and Department of Education consultants to explore these initiatives was proposed and begun.

It was proposed that since the elementary schools were just beginning the process of using Internet and other information technologies to develop resource-based learning and to teach information literacy skills, this project would provide an opportunity to apply a school-wide approach to learning about these new technologies and to identify strategies that make effective use of them. Research into the literature and collaborative planning among the partners was started.

Initially, faculty members partnered with the teachers and teacher-librarians in the schools where they supervised pre-service teaching placements. Each faculty member drew upon a subject area of his or her own expertise in which to focus the projects. Working with a pre-service teacher as an assistant researcher, the faculty member consulted with the school-based personnel about developing specific projects. In the first year, a variety of projects were attempted and completed.

One year-long project was in the process of being developed by the Department of Education and a school staff. One faculty member and pre-service teacher joined this group to contribute to the planning and implementation. This project involved the Grade 5 Social Studies curriculum in which the students study their own community. The information technology component was in the proposed publishing of their research in a web-based environment and communicating about this information with other island-based students, within and outside of the country. E-mail was used in the early communication, and plans were made to include an communication component in the web-based environment.

Another faculty member worked with several pre-service teachers as research assistants. The research assistants set up the projects with the classroom teachers and teacher-librarians. These projects utilized the World Wide Web as a resource for gathering information and developing information literacy skills as they relate to internet sites.

A third faculty member worked with two teachers in Grade 2 at one school with very different teaching styles, as well as with a pre-service teaching assistant. The focus was on patterning and problem-solving in mathematics using a computer program environment which allowed both structured tasking and free exploration. The computer-based activities mirrored and extended the classroom activities although both structured tasking and free exploration were used with all students.

Other projects were mounted within the Language Arts area of the curriculum by a fourth faculty member and two pre-service teachers. The three projects were a collaboration between the faculty member, classroom teachers, pre-service teachers and Department of Education consultant where the focus was on creative writing. Two of the projects utilized a word-processor to publish their poetry while learning the functions of the application and the third project involved electronic communication about writing through the Writers in Electronic Residence Program.

Although each project yielded interesting subject-specific information, this paper will focus on the conceptual issues associated with the development of integrated IT projects. These issues include: 1) Learning computer skills contextually; 2) Examining the changing role of the teacher; 3) Identifying a new continuum for integrating IT into the learning environment, and 4) Designing projects from the curriculum to the technology. Examples from the mathematics, language arts, social studies and school library programs will be used to support and illustrate these points.

Learning Computer Skills in Context

The first issue of learning computer skills in context relates to identifying the context. Sharp (1999), in addition to a historical overview and a description of the structure and function of computers, introduces teachers to the hierarchical approach to skill development in various computer applications. The ultimate goal in this approach is to integrate the use of computer application with core subject area development. In contrast, Schwartz and Beichner (1999) describe classroom situations where information technology use would be advantageous. They illustrate with examples of active learning activities which spark the need for students to create their own processes or for "mini-lessons" introducing or reviewing knowledge, skills or processes, in the context of the activity.

Both of these perspectives are reflected in the IT projects developed for the *Teaching and Learning with Information Technologies Research Project*. A few projects started by identifying the computer skills that students needed to have success in the project. These skills were taught and practiced in the context of learning existing curriculum as suggested by Sharp.

The resource-based learning project within the area of social studies started with this perspective. Since the web-program, Zebu, was very new, the skills the students would need to publish their work were identified and taught before the students independently typed the information into the frames. The classroom teacher and teacher-librarian had been previously trained by the software developers and set up the template for the students to follow. It was found that mini-lessons

needed to be taught to address skills that had not been identified and to reteach skills in context.

On a slightly smaller scale, the poetry project where the students were publishing their own poetry, the skills of word-processing had been introduced previously. The students were reminded of these skills at the beginning of the class and were to practice them with this project. With limited access to computers, teaching the skills first–sometimes without the computer present–is the only way to make efficient use of the available computer time.

Other projects started by identifying what students need to learn according to the school curriculum and then sought ways that IT could facilitate their learning. Consequently, the students learned and used their technological skills while engaged in active learning activities that matched curricular goals and learning outcomes which follows Schwartz and Beichner.

In one of the information literacy projects, discussion started among the different participants with a focus on the curriculum content which would be taught next. The student teacher planned to add internet resources to the "regular" features of the lessons. Web sites were selected for the children to explore to find the information. The students were taught how to access some of the information through books. No additional information was provided for students on accessing the information from the web sites. The students created their own strategies which ranged from efficient to very inefficient. It will be interesting to see if further exposure to information technologies would enable students to create their own effective and efficient strategies.

Projects involving the web-based program, Zebu, as well as further poetry publishing, math and information literacy projects used a combination of student developed strategies and brief instruction if problems were encountered. For example, the students in the math project used the mouse and clicked and dragged where necessary. Time was given for students to have several unsuccessful tries before any suggestions were made. The one exception to this was when the students "ran out of room" to move the mouse, they were told they could pick it up and place it somewhere else. It was through experience that we discovered that most students did not try that strategy early in their experiences and it avoided a lot of frustration if timely information was given.

The Role of the Teacher

There are many different views of what the teacher's role should be in the learning process. For the most part these views are directly related to the theory of learning which a person holds. This concept is of interest as in 1990, Bigum noted a connection between the microcomputer applications which teachers used and their teaching methods and curriculum without the technology. He postulated that teachers use microcomputer applications which complement their teaching methods and curriculum. He suggested that drill & practice, simulation, and tutorial software, or "child-minding software" (p. 66) in the classroom may have strained teachers' creativity and that it was easier for them to find applications for the genre of software called "computing tool software" (p. 66) which included word processing and databases. Part of the

reason for this difference he attributed to teachers assimilating computer uses which add to or complement their existing curriculum, including teaching methods. Thus he indirectly concludes that most computer using teachers follow a developmental approach in their teaching and the "tools" can accomplish the same tasks as usual only easier. Therefore, we need to examine the accepted roles of teachers in more depth.

The traditional role of a good teacher is one in which the teacher establishes learning outcomes and plans a sequence of learning activities which develop from the simple to the complex. This is very consistent with the behavioural perspective of learning based on B.F. Skinner's work. This perspective is in tension with the progressive idea of a good teacher. The progressive idea of a good teacher is where the teacher's role is to draw out each learner's potential competencies. In this role the teacher facilitates the activities that the learner engages in which serve their interest and needs. Learner experiences and dialogue are the key teaching strategies. The conception of this teacher's role matches with the developmental approach associated with the learning theories of Piaget and Vygotsky.

Unfortunately, problems arise with the traditional approach because the more the teacher plans, organizes and presents the more uninvolved the students tend to become, and thus the classroom becomes very teacher-centred. The teacher may doing everything right according to this perspective, but the students may not be learning to their full potential. On the other hand, not all students come to class prepared to be self-directed learners and have difficultly find engaging tasks for themselves to advance their own learning. Out of this dilemma, a third school of thought has emerged--the cognitive approach.

Although Grow's Self-Directed Learning Model is based on adult learning, parallels can be drawn between the cognitive approach and the four stages of his model of learning. These parallels are worthy of note and consideration. In the first stage, the student is dependent as she or he lacks the relevant knowledge, skills, and experience. At this stage, explicit directions are sought about what to do and how to do it. The role of the teacher is to provide demonstrations, informal lecture, and supervised practice. Gradually, the student becomes more self-directed, until the other end of the spectrum at the fourth stage. At this stage, students are keen and capable of setting their own goals and standards, with or without help from experts. The role of the teacher evolves to that of a consultant or resource person.

The constructivist philosophy of teaching, which falls into the cognitive approach, provides the theoretical interpretation of Grow's Self-Directed Learning Model. The philosophy involves four major assumptions even though in practice it may encompass a range of teaching strategies and beliefs. The four corner stones of theoretical constructivism are prior experience, personal construction of meaning, contextual and shared learning, and changing roles for teachers and learners. As teachers and students progress through the stages of Grow's Model, one can identify where the beginning experience is provided through direction from the teacher. The learner becomes progressively more independent and self-directed until the teacher and learner roles are quite different than in the first stage.

Advocates of information technology use in the classroom, suggest that its use will transform the role of the teacher from that of the traditional perspective to the developmental or cognitive perspectives. Or from a controller to a facilitator. They imply that information technology, on its own, would be the change agent need to make this transition and minimize the influence of a teacher. As with previous technologies which have made similar claims and have historically shown that very little change in classroom practices has resulted (Cuban 1986), these claims should be viewed with caution.

Identifying a new continuum for integrating IT into the learning environment

The potential of technology to transform education has been described by Schwartz and Beichner (1999) through a principle they are developing called the Delta Principle. In the first level, the user of the technology accomplishes the same pre-technology task in the same way only it is easier, quicker or otherwise more efficiently. Maddux, et al. (1997) also describe this level as a Type I application where neither the content nor the teaching strategy changes; it just now uses technology in a similar way to accomplish the same end.

Level II of the Delta Principle is the transitory stage where the technology is applied in new ways. This leads to Level III which is when a technology's use is expanded beyond the original intent of accomplishing a pre-existing task quicker or more efficiently, and new uses or kinds of tasks are developed which could not exist without the technology. This level is characterized by Maddux, et al. (1997) as "Type II" where it is asserted that such technology use will "make available new and better ways of teaching." (P. 18) Owen et al. (1995) give examples how internet-based experiences change the way students, teachers, and others engage and interact with one another They describe how visual cues are removed in an internet-based experience which potentially leads to flattening existing heirarchies. "It is the *expertise of their experience* and the fact they they bring it to the exchange that counts" (Owen et al., 1995, p. 179).

Examining the projects and the processes used to develop the projects, four different categories characterizing types of processes of development and resultant products can be identified. To some extent they follow the postulated "Delta Principle" but the focus is equally on the process used to develop the project as on the project itself.

The first approach addressed here is referred to as the Isolated Approach. In this approach the teacher finds an interesting project at a conference, in a web-site or in teacher guidebook which focuses on using an information technology. An example is Novelli's article in Instructor, 1993 about three teachers' great ways to "create meaningful, high-interest lessons" (p. 37). It is a great idea, it will really spark up the class, and the school has the technology with which to do it! The teacher pops into class on Monday morning ready to start with no more thought put into it. It may or may not match the curriculum or be appropriate for the students. It is the most tempting approach to take when confronted with the idea of integrating information technology into the classroom. The more teacher-proofed and self-contained the better. However, it is an add-on rather than being integrated, and in only the best-case scenarios does it lead to more thoughtful

planning and curriculum integration. The Isolated Approach is the technology equivalent of "What will I do Monday morning?"

Another approach to creating and carrying out information technology projects is referred to as the Innovative Approach. In the Innovative Approach, the teacher or innovator has just discovered a tool or program which is new to them. In his enthusiasm, the teacher either tries to use this innovation for everything in his curriculum, or looks at his curriculum through new lenses which highlights the multitude of ways that this one "innovation" can be used. This approach is also referred to as the 'Techie Focus' where the technology will be used whether appropriately or not, just because it is new (at least to the teacher in the classroom). An example of this approach is when a teacher has attended a workshop on using word-processing in the classroom. All of a sudden, everything can be done on the word processor from practising typing by spelling words to moving through the page answering arithmetic computation questions to publishing a social studies report. Everything can be done with this indispensable tool. This is also a common approach taken with any new innovation and is well documented in the literature.

A more deliberately thought out approach to planning is referred to the Integrated Approach. This is the Type I application as described by Maddux et al. (1997). The project is curriculum-based with the deliberate teaching of the technology. The project is virtually the same as a pre-technology project would be, but the project is accomplished quicker, more elaborately, or in the same manner only using the technology. Designing projects in this way requires a thorough understanding of both the curriculum and the basics of the technology used. These are the types of projects which this project was trying to develop. Projects of this type may evolve out of an initial Isolated or Innovative Approach, but, as we found out, it is also possible to start at this level especially by using collaborative planning where the curriculum expert, the technology guru, and the "neat ideas" person do not have to be the same classroom teacher. This approach also appears to be almost self-sustaining once it is established.

The Assimilated Approach is characterized by the Type II application described by Maddux et al (1997). In this approach, the technology use is an integral part of the curriculum planning process and the projects could not happen without the technology. This illustrates a seamless integration of the technology and for many this is the ideal for integrating information technologies into the curriculum. Windschetl (1998) acknowledges that the web seems to be transforming the way things have always been done even if we do not yet understand how.

Each of these approaches by the teacher is mirrored by the reaction of students to information technologies. These student reactions, however, are not necessarily prompted by the approach taken by the teacher as all four reactions are possible even if only one approach is used.

The Isolation Reaction is characterized by the students treating the technology as a foreign object, and a distasteful one at that. The student routinely expresses ideas indicate that he or she does not perceive the technology as part of she or his world. An example from the mathematics project involved a young lad in Grade 2 who was a "good" math student in class (i.e., could answer questions in class and got all of his seat work right). When it came time to do the same concepts

on the computer, he was unable to solve the simplest problem and was unable to make any connection with the class work. Specifically, while he could solve the problem using tactile objects or paper and pencil, he was unable to manipulate the on-screen images or make a connection between the on-screen images and the tactile objects. He expressed frustration about using a computer because it had "nothing to do with anything he was interested in."

In contrast, the Innovative Reaction is usually one of enthusiasm by the students for the technology. The technology is seen as a novelty and is intrinsically fascinating. The student is willing to spend time exploring and it is often a first choice for an activity. It is usually perceived as a "game" where learning the content is peripheral at best. An example of this reaction from the language arts project is where several students were fascinated by the fonts and colour available with the word processor and colour printer. The task was to publish their poem using the features of the word processor but the poem was lost in the rainbow of colours for every different font and size used. Not an unusual reaction for something new.

A student exhibiting an Integration Reaction is characterized by the quote, "Oh, this is the same as what we did in class!" The student sees the technology as an alternate way to accomplish the same task and usually uses the same procedures with or without the technology. An example of an Integration Reaction is the first Islands Project. In this project the students researched information about their community using print material and oral histories. The students then drafted their reports and then typed them into the frames of Zebu for publishing to the web. In this case the technology was seen as a more efficient or consistent way to publish a report.

The last category illustrates an Assimilation Reaction and includes students who seem to connect with the technology, referred to as Nexus Kids. These students seamlessly interact with the technology, make new connections, appear to "invent" new knowledge, and are an "expert." A dramatic example of the Nexus Kid is from the mathematics project. A rather shy boy, who had the distinction of not being able to follow nor give the simplest instructions in class, joined two other students at the computer. All three students had reported that they had never used a computer before. He observed as the others tried to interact with the technology. When it was his turn, he used the mouse very naturally and explained to the other students why he was doing what he was doing. He did not use mathematical terms but he very effectively explained the concepts in relation to his interactions with the technology. He expressed great pleasure at being able to use the computer and wanted to use it all the time. This boy was able to go back to class and solve similar problems, and explain how he solved them in terms of how it would work with the technology. The technology forged a link to learning for him and by using the technology he was able to create his own knowledge successfully. Nexus Kids are what is often thought of as the pinnacle of achievement in integration of technology. Is it? Or is it an alternative learning style? Durin (1995) concludes that with technology, "students are willing to take the time needed to create excellent products to communicate their ideas. And, if they can communicate them, they understand them" (p. 168).

Designing projects from the curriculum to the technology

In identifying three issues of learning computer skills in context, examining the changing role of the teacher, and identifying a new continuum for integrating IT into the learning environment, it is hoped that these issues might inform the designing projects which integrate information technologies into the curriculum of the classroom. There are many studies which have followed the introduction of innovations into classrooms (such as Fullan, 1982 and 1985). Most of these introductions have failed chiefly because the innovation was introduced in isolation and was viewed as an expendable add-on to an already overloaded curriculum. Therefore, starting with the curriculum and moving to introduce aspects of the information technologies, where appropriate, would be a more successful route.

There are three areas which are critical for the classroom teacher if he or she is to develop successful projects in this manner. These areas include the teachers' attitudes and philosophy, technology support available, and teachers' personal knowledge and skills.

Classroom teachers' attitudes and philosophy about and toward information technologies and teaching play an important role. Sometimes these attitudes and philosophies can be discussed and written about, but mostly they are practised on a moment by moment basis in the classroom. To successfully integrate information technologies into the curriculum in this manner, the classroom teacher must be willing to either allow the students to invent the skills they need, or teach the skills needed as the students progress through the project. By attempting to teach all of the skills the students will require before beginning the project, the perspective would change to that of an add-on rather than an integrated project. Additionally, the classroom teacher's philosophy of teaching with technology should be curriculum-based with deliberate teaching of the technology within the curriculum, or of using the technology as an integral part of the project where the project could not be completed without the technology. Both of these approaches position the technology as an equal partner in the learning of the curriculum. If the technology is viewed as a nine-day wonder, it will be. Finally, the classroom teacher must be willing and able to go through the stages of her or his own development using the technology with the curriculum. Success is not instantaneous for most. It takes repeated efforts and the security of being able to continue trying new ways that may or may not work the first time. The ability and freedom to learn from mistakes and the less than spectacular results will allow refinement, confidence and success to develop.

Along with teachers' attitudes and philosophies which are compatible with this approach, the availability of technology support is critical (Duffield, 1997). There are three aspects to the technology support which include the availability of the hardware when needed, appropriate software and level of skills, and accessible expertise in the case of hardware or software anomalies. Unfortunately, projects which integrate information technologies require the appropriate hardware be available when needed. This includes both the physical access to the hardware by the students and the reliability of the equipment. If your class has access to the technologies for three months of the year, those are the only months you could successfully integrate the technologies. Additionally, the hardware must be reliable enough so that it can be used when needed. The appropriate software also needs to be available and with sufficient legal copies for the classroom project. With the lab sets, class sets, and site licences available, this is

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becoming easier to accomplish. The skill level needed to have success with the software also needs to be in the range of the class and the teacher. For example, a Grade one class should not have to learn to program in SQL to use a database successfully. Finally, the classroom teacher needs to either have the skill to solve the common glitches encountered with the technologies, or have access to an expert on short notice. If the technologies fail and the problem not solved quickly, the whole project suffers and a second attempt is unlikely.

The individual teacher's knowledge and skills are critical in developing information technology projects from the curriculum to the technology (Zammit, 1992, Cumming, 1988). The teacher must have a familiarity with the curriculum to the level where he or she can identify areas where she or he could use the information technologies to make a difference. The classroom teacher must also have basic skills with the technology to the extent that they are willing to allow their students to use it. This will vary among individuals as to what the basic level is for them. Some teachers like to know more than their students when introducing something new, others are willing to let the students teach them.

In all cases to successfully integrate IT into the curriculum, there must be the foundations of good teaching where the teacher meets the needs of the students in terms of both content and presentation. Without good teaching, the value of the integration of IT is called into question (Miller & Olson, 1994).

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